Soil Management for Forage Production in Wyoming

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Overview

- Forage production in Wyoming
- Production constraints
- Addressing the constraints
- Do they work in Wyoming?
Advantages of Fertilizer

- Effectively increases yields, even in soils with low native fertility;
- High nutrient concentration facilitates transport and application;
- Feeds the world: green revolution genetics.
Disadvantages of Fertilizer

- Petro-chemical dependency: 33,000 cubic feet of natural gas required to produce one ton of N fertilizer;
- High NG prices have pushed most nitrogen fertilizer production out of the U.S.;
- Over-fertilization contaminates ground and surface waters;
- Long-term use depletes soil organic matter;
- Skyrocketing prices may create an opportunity to reassess operations and incorporate practices that reduce the need for fertilizer.
Forage Production in Wyoming
Number of Wyoming Farms, 2002

- Irrigated pasture, 2,570
- All hay, 4,680
- Wheat, 315
- Barley, 364
- Oats, 197
- Dry beans, 227
- Sugar beets, 181
- Potatoes, 11
- Vegetables, 18
- Irrigated pasture, 2,570
- All hay, 4,680
- Wheat, 315
- Barley, 364
- Oats, 197
- Dry beans, 227
- Sugar beets, 181
- Potatoes, 11
- Vegetables, 18
Acres Harvested in Wyoming, 2002

- All hay: 581,258 acres
- Wheat: 120,471 acres
- Barley: 36,105 acres
- Oats: 711 acres
- Beans: 60,648 acres
- Sugar beets: 127 acres
- Potatoes: 30,151 acres
- Vegetables: 3,399 acres
- Irrigated pasture: 892,259 acres
Cash Receipts in Million Dollars, 2006

- Hay: 48.3
- Sugarbeets: 34.3
- Wheat: 16.5
- Corn: 13.1
- Dry Beans: 12.9
- Barley: 12.8
- Other Crops: 6.5
- Greenhouse and Nursery: 2.0
- Oats: 1.0
- Oil Crops: 0.9
- Fruits and Nuts: 0.2
Cash Receipts in Millions of Dollars, 2006

- Cattle and Calves: 762.6
- Hay: 48.3
- Sugarbeets
- Hogs
- Sheep and Lambs
- Other Livestock
- Wheat
- Dairy Products
- Corn
- Dry Beans
- Barley
- Other Crops
- Greenhouse and Nursery
- Wool
- Honey
- Oats
- Oil Crops
- Poultry / Eggs
- Fruits and Nuts
Squeaky Wheel

Sugar Beet
<table>
<thead>
<tr>
<th>Crop or Livestock Item</th>
<th>U.S.</th>
<th>Wyoming</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Size of Farms &amp; Ranches</td>
<td>446</td>
<td>3,780</td>
<td>1</td>
</tr>
<tr>
<td>Wool</td>
<td>36,019</td>
<td>3,550</td>
<td>2</td>
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<tr>
<td>Breeding Sheep</td>
<td>4,620</td>
<td>350</td>
<td>2</td>
</tr>
<tr>
<td>All Sheep &amp; Lambs</td>
<td>6,185</td>
<td>460</td>
<td>3</td>
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<tr>
<td>Market Sheep &amp; Lambs</td>
<td>1,565</td>
<td>110</td>
<td>4</td>
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<tr>
<td>Pinto Beans</td>
<td>9,618</td>
<td>510</td>
<td>5</td>
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<tr>
<td>Barley</td>
<td>180,051</td>
<td>4,731</td>
<td>7</td>
</tr>
<tr>
<td>Land in Farms &amp; Ranches</td>
<td>932,430</td>
<td>34,400</td>
<td>8</td>
</tr>
<tr>
<td>Sugarbeets</td>
<td>34,064</td>
<td>798</td>
<td>9</td>
</tr>
<tr>
<td>All Dry Beans</td>
<td>24,247</td>
<td>590</td>
<td>9</td>
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<tr>
<td>Spring Wheat (other than durum)</td>
<td>460,480</td>
<td>234</td>
<td>11</td>
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<tr>
<td>Beef Cows</td>
<td>32,894</td>
<td>763</td>
<td>14</td>
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<tr>
<td>Cattle on Feed</td>
<td>14,269</td>
<td>90</td>
<td>19</td>
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<tr>
<td>Alfalfa Hay</td>
<td>71,666</td>
<td>1,400</td>
<td>21</td>
</tr>
<tr>
<td>All Cattle &amp; Calves</td>
<td>97,003</td>
<td>1,430</td>
<td>22</td>
</tr>
<tr>
<td>Oats</td>
<td>93,764</td>
<td>684</td>
<td>26</td>
</tr>
<tr>
<td>All Hay</td>
<td>141,666</td>
<td>2,115</td>
<td>29</td>
</tr>
<tr>
<td>Other Hay</td>
<td>70,000</td>
<td>715</td>
<td>29</td>
</tr>
<tr>
<td>All Hogs and Pigs</td>
<td>62,489</td>
<td>100</td>
<td>30</td>
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<tr>
<td>Corn for Silage</td>
<td>104,849</td>
<td>748</td>
<td>30</td>
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<tr>
<td>Winter Wheat</td>
<td>1,298,081</td>
<td>3,645</td>
<td>33</td>
</tr>
<tr>
<td>Corn for Grain</td>
<td>10,534,868</td>
<td>5,805</td>
<td>35</td>
</tr>
</tbody>
</table>
Historic Alfalfa Production

From Wyoming Agricultural Statistics, 2006
Historic Alfalfa Production

From Wyoming Agricultural Statistics, 2006
Production Constraints

- Nutrient availability: low organic matter, high CaCO$_3$ and pH;
- Saline, sodic, or saline-sodic soils;
- Water management;
- High costs and limited options for fertilizers;
- Cold weather;
- Water quality;
Role of SOM

- Soil organic matter improves soil tilth, or structure and the soil’s ability to hold and release moisture and nutrients;
High pH increases Ca & Mg to point that can restrain P availability;

Limits availability of micronutrients, especially Fe and Zn;

Testing soil for micronutrient availability pays.
Salinity & Sodicity

- Classes of plants showing reduction in growth:
  - Haleophytes
  - Tolerant
  - Moderately tolerant
  - Moderately sensitive
  - Sensitive

- Electrical conductivity (dS/m) vs. Sodium adsorption ratio (SAR):
  - Saline soils pH < 8.5
  - Saline-sodic soils (soil pH generally < 8.5)
  - Normal soils pH < 8.5
  - Sodic soils (soil pH > 8.5)

- Estimated exchangeable sodium percentage (ESP):
  - 0 to 10
  - 10 to 15
  - 15 to 20
  - 20 to 30
  - 30 to 40
  - 40 to 50
  - 50 to 60

- Graphic elements:
  - Plants transpire water
  - Water evaporates
  - Salts remain behind
  - Water and salts move upward from a high water table
Sodium

- High Na content disperses clays and impedes permeability;

- Gypsum not generally useful in Wyoming because soils are already saturated with Ca;

- Elemental S at 500-1000 lbs/acre can be effective, but adequate drainage and good quality water are needed to remove the sodium.
Proper water management with clean water optimizes fertilizer applications;

Improper management can make it a waste of time and money:
- Too much water leaches away plant available nutrients and concentrates Na and salts at the surface;
- Too little water or bad timing can lead to losses through volatilization or failure to move nutrients into root zones;
- Water with even small amounts of salts or Na can degrade soils in ways that are impossible to reverse;

Can water management improve on Wyoming flood irrigated hay meadows and pastures?
High Costs and Limited Options for Fertilizer

- Cost and N and P fertilizers have skyrocketed to levels that can make their use cost-ineffective on low-yield hay meadows;

- Ammonium-nitrate, the best N formulation for perennial crops, is no longer available;
  - Urea requires careful management to incorporate with water before volatilization – high pH exacerbates;
  - UAN and other liquids are most effective if incorporated with coulter or spoke-wheel injector – equipment investment;

- P is rapidly tied up so needs must be met each year:
  - Advantages of liquid P products generally don’t offset higher costs on alfalfa applications.
No magic solutions

- A number of “proprietary formulas” have shown up because producers are looking for alternatives;

- Research and experience suggest that you can’t get more nutrient than you put on.
  - Products that claim higher use efficiency and therefore lower N content have not panned out, but who knows?

- No reliable screening process means buyer beware;

- Results from sugar beet trials on testing five N products:
  - placement is more important than formulation;
  - urea is the best option economically;
  - Soil test rates were about ½ the rate normally used and returned more yield per N fertilizer dollar.

- More work is needed on best options for Wyoming.
Organic Hay Production

- Manure is the best way to supplement fertility;
- P can be an issue because most common organic-approved product is not effective on our soils;
- Humates can provide specific micronutrients, like Fe, but cannot make a dent in SOM content at economical rates;
- There is growing interest from producers and need for research and extension for Wyoming.
Addressing Constraints
Using manure to supplement fertility

About 25 percent of N is available the first year;

100 lbs N per acre requires about 33 tons/acre of cow manure or 44 tons/acre of horse manure;

If a manure spreader holds 4 yards, that’s 12 spreader loads of cow manure or 16 loads of horse manure;

SOM contribution in long-term is more important than immediate nutrient contributions.

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**Table 1. Typical nutrient content, solids content, and bulk density of uncomposted animal manures at the time of application.**

<table>
<thead>
<tr>
<th>Type</th>
<th>N</th>
<th>P²</th>
<th>K</th>
<th>Solids (%)</th>
<th>Bulk Density (lb/cu yd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broiler with litter</td>
<td>73</td>
<td>28</td>
<td>55</td>
<td>70</td>
<td>900</td>
</tr>
<tr>
<td>Laying hen</td>
<td>37</td>
<td>25</td>
<td>39</td>
<td>40</td>
<td>1400</td>
</tr>
<tr>
<td>Sheep</td>
<td>18</td>
<td>4.0</td>
<td>29</td>
<td>28</td>
<td>1400</td>
</tr>
<tr>
<td>Rabbit</td>
<td>15</td>
<td>4.2</td>
<td>12</td>
<td>25</td>
<td>1400</td>
</tr>
<tr>
<td>Beef</td>
<td>12</td>
<td>2.6</td>
<td>14</td>
<td>23</td>
<td>1400</td>
</tr>
<tr>
<td>Dry stack dairy</td>
<td>9</td>
<td>1.8</td>
<td>16</td>
<td>35</td>
<td>1400</td>
</tr>
<tr>
<td>Separated dairy solids</td>
<td>5</td>
<td>0.9</td>
<td>2.4</td>
<td>19</td>
<td>1100</td>
</tr>
<tr>
<td>Horse</td>
<td>9</td>
<td>2.6</td>
<td>13</td>
<td>37</td>
<td>1400</td>
</tr>
</tbody>
</table>

1. Dairy manure data and some horse manure data were collected in the Pacific Northwest. Other data sources are listed in Additional Resources.
2. Manure analyses are usually reported in terms of P and K, while fertilizer labels use P₂O₅ and K₂O. To convert from P to P₂O₅, multiply P by 2.3. To convert from K to K₂O, multiply K by 1.2.
3. As-is is typical moisture content for manure stored under cover.
Manure on irrigated pastures & hay meadows

- Grass pastures & hay meadows respond to added N;
- SOM can be depleted after long-term use, so manure can benefit;
- Harrowing pastures can spread existing manure for more uniform fertility, but may not be cost effective;
- Alfalfa N fixation can be suppressed, but yields reportedly respond to manure application, likely from P;
Using legumes to supplement fertility

- Plants in the pea family have symbiotic relationship with bacteria that infects roots and is able to fix N\(_2\) gas from soil air for use conversion to organic N in plant tissue;
- N becomes available to other plants upon decomposition or animal excretion;
- 80 to 90 percent passes through livestock but 50% in urine is lost to volatilization.
Using legumes to supplement fertility

- Add correct inoculant for maximum fixation;
- Values for whole plant, solid stand;
- About half in stubble and roots.

<table>
<thead>
<tr>
<th>Legume</th>
<th>Typical N Fixed (lbs/acre/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>194</td>
</tr>
<tr>
<td>Ladino clover</td>
<td>179</td>
</tr>
<tr>
<td>Sweet clover</td>
<td>119</td>
</tr>
<tr>
<td>Red clover</td>
<td>114</td>
</tr>
<tr>
<td>White clover</td>
<td>103</td>
</tr>
<tr>
<td>Vetch</td>
<td>80</td>
</tr>
<tr>
<td>Peas</td>
<td>72</td>
</tr>
<tr>
<td>Winter peas</td>
<td>50</td>
</tr>
<tr>
<td>Beans</td>
<td>40</td>
</tr>
</tbody>
</table>
Legumes in pastures

- Once established grasses utilize soil N from decomposing legume litter and manure and less competitive legumes utilize N fixed from atmosphere;

- Manage to maintain balance:
  - N fertilizer favors grasses and can reduce legumes;
  - Mixed stands often respond to P;
  - Research shows that managed (rotational) grazing can increase legumes relative to grasses but continuous grazing can reduce or eliminate legumes.
Adding legumes to pasture or hayland

- Overseeding might be successful in the right conditions in spring;
- Need adequate, high soil test P and K (don’t add N);
- Mow grass short and drill or broadcast legume: 15-20 lbs for alfalfa, 20-30 or vetch, 4-6 for birdsfoot trefoil;
- Drag or harrow after seeding if broadcast to improve seed soil contact;
- Don’t graze first year, but mow as necessary to favor legumes.
Summary

- Wyoming hay producers are a huge but relatively quiet clientele: Until Now.
- Cost and availability of fertilizers are causing them to scrutinize management practices;
- Water management and proper fertilizer use are key;
- Legumes, grazing, management, and manure application could reduce fertilizer bills and improve soils;
- Lots of room for work on research & extension.